Fast Response Chemical, Biological, & Radiological Dispersion Modeling in Cities

What is QUIC?

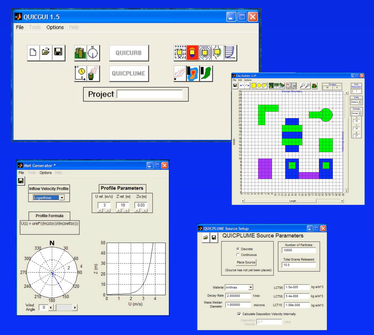
The Quick Urban & Industrial Complex (QUIC) dispersion modeling system

DC Mall tracer dispersion simulation

QUIC is comprised of:

* QUIC-URB
  produces 3D wind field around buildings using empirical/ diagnostic model
* QUIC-PLUME
  accounts for building-induced turbulence through Lagrangian random-walk dispersion model
* QUIC-GUI
  graphical user interface for set-up, running, and visualization (QUIC-GUI)

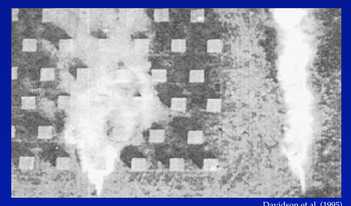
The QUIC Graphical User Interface



The QUIC-GUI allows for the user to easily set-up building layouts, specify the winds, choose a CBR agent type, and pick a release location.

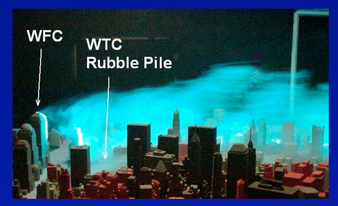
2D and 3D visualization tools allow the user to rapidly display wind flow and plume dispersion patterns.

Why Account for Buildings?

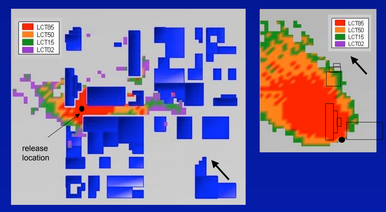


Davidson et al. (1995)

Buildings enhance lateral spread. Plan view of smoke dispersing over flat terrain (right) and going through an array of buildings (left). USEPA wind tunnel experiment.



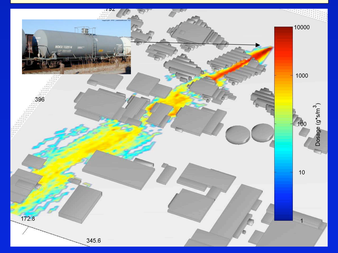
Buildings enhance vertical spread. Side view of smoke being lofted high into the air by tall buildings. USEPA experiment from Heist et al. (2004).



Lethal concentration threshold patterns are different when buildings are included (left). There is no cross-wind channeling in the non-building aware simulation (right).

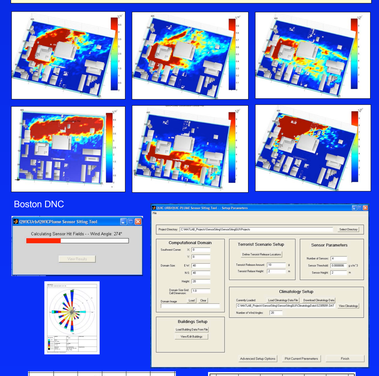
How has QUIC been used?

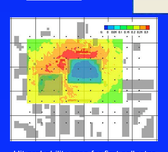
Vulnerability & Threat Assessments



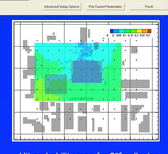
A chemical spill vulnerability assessment for a rail car accident.

CBR Sensor Siting for Special Events





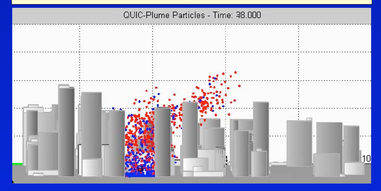
Hit probability map for first collector



Hit probability map for 2nd collector

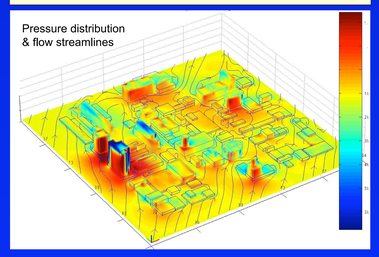
The QUIC Collector Siting GUI is an automated tool for determining the best (and worst) places to put bio collectors around a building complex.

RDD Explosive-Driven Events



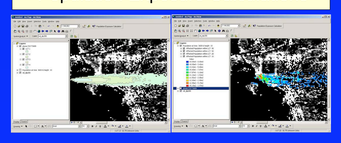
An explosive release of radioactive particles in a high-rise area showing lofting of lighter particles (red) and trapping of heavier particles (blue).

Outdoor-to-Indoor Infiltration



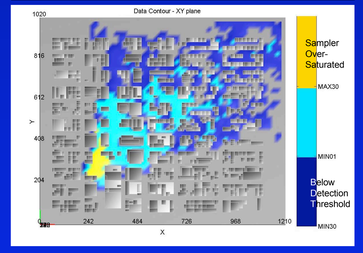
Pressures on building surfaces can be computed by QUIC as in this Salt Lake City Simulation. The pressures can then be provided as boundary conditions to indoor models to simulate indoor dispersion.

Population Exposure Calculations



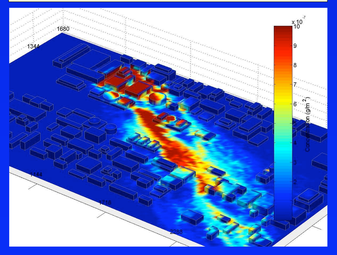
An automated ArcGIS mapping tool can import a QUIC-generated plume (left) and compute exposures to the population (right).

Urban Field Experiment Design



Simulations can be performed to determine how much tracer needs to be released in order to be detected by the samplers, but not over saturate them. Midtown Manhattan simulation.

Clean-up & Restoration Studies



Deposition can be calculated on the ground as well on building walls and roofs as in this Washington DC Mall example. The mass of agent on individual faces or buildings can be provided in order to help estimate the magnitude of clean-up efforts.

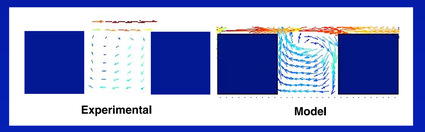
Table-top Training Exercises

Real-time Response for Specific Sites

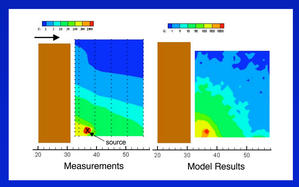
How accurate is QUIC?

QUIC has been tested against both field and wind-tunnel data (see below), but due to the complexities of urban dispersion more testing is needed and is ongoing.

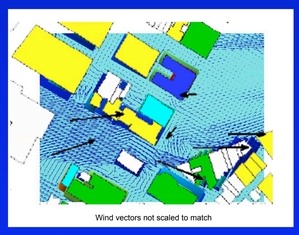
QUIC will never give perfect answers, but the it will account for the effects of buildings in an approximate way and provide more realism than non-building aware dispersion models.



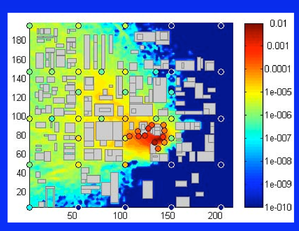
Comparison of vortex circulation in a street canyon wind-tunnel experiment.



Wind-tunnel comparison of the concentration field behind a “high-rise” building.



Wind field comparisons using L. Manhattan wind-tunnel data (Bowker et al., 2004).



Plume dispersion comparisons with Salt Lake City Urban 2000 field data (filled circles).

QUIC is a fast response urban dispersion model that runs on a laptop. CBR agent dispersion can be computed on building to neighborhood scales in tens of seconds to minutes.

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University of U